

IN THE CLAIMS:

Please amend the claims as follows:

1. (Currently Amended) An apparatus, including

a mass storage device including one or more disk drives, each disk drive having a plurality of storage blocks, each of said storage blocks including a plurality of sectors, said storage device using parity data for error detection;

wherein each storage block of said plurality of storage blocks includes a data portion and an error code portion, said data portion storing data for said storage block, and said error code portion being responsive to said data portion; and

~~wherein said error code portion includes integrity data for checking integrity of said error code portion;~~

wherein said error code portion includes a checksum of said data portion.

2. (Previously Presented) An apparatus as in claim 1, wherein said disk drives are hard disks.

3. (Previously Presented) An apparatus as in claim 1, wherein said disk drives are part of a RAID storage device.

4. (Original) An apparatus as in claim 3, wherein said RAID storage device is a RAID level 4 device.

5. (Original) An apparatus as in claim 1, wherein said error code portion is appended to said data portion.

6. (Cancelled)

7. (Currently Amended) An apparatus as in claim 1 [[6]], wherein said checksum includes 4-bytes of checksum data.

8. (Currently Amended) An apparatus as in claim 1 [[6]], wherein said checksum is included in a block-appended checksum.

9. (Previously Presented) An apparatus as in claim 8, wherein said block-appended checksum includes a further checksum for checking integrity of said block-appended checksum.

10. (Previously Presented) An apparatus as in claim 9, wherein said further checksum includes 4-bytes of data.

11. (Original) An apparatus as in claim 1, wherein said mass storage device includes a cache or RAM.

12. (Previously Presented) An apparatus as in claim 1, wherein said disk drives are formatted with 520-bytes per sector.

13. (Previously Presented) An apparatus as in claim 1, wherein said plurality of said sectors included in each of said storage blocks is eight sectors.

14. (Original) An apparatus as in claim 1, wherein said error code portion includes 64-bytes of error code data.

15. (Original) An apparatus as in claim 1, wherein said data portion includes 4,096-bytes of data.

16. (Original) An apparatus as in claim 1, wherein said sectors include 520-bytes of data storage.

17. (Original) An apparatus as in claim 1, wherein said storage block includes 4,160-bytes of data and error code storage space.

18. (Currently Amended) An apparatus, including

a mass storage device including one or more disk drives, each disk drive having a plurality of storage blocks, each of said storage blocks including a plurality of said sectors, said storage device using parity data for error detection;

wherein for each storage block of said plurality of storage blocks, a first subset of said storage block is responsive to data for said storage block, a second subset of said storage block is responsive to error code information, and said error code information is responsive to said data; and

~~wherein said second subset of each storage block includes integrity data for checking integrity of said second subset;~~

wherein said error code information includes a checksum of said first subset.

19. (Previously Presented) An apparatus as in claim 18, wherein said disk drives are hard disks.

20. (Previously Presented) An apparatus as in claim 18, wherein said disk drives are part of a RAID storage system.

21. (Original) An apparatus as in claim 20, wherein said RAID storage system is a RAID level 4 system.

22. (Original) An apparatus as in claim 18, wherein said second subset is appended to said first subset.

23. (Cancelled)

24. (Currently Amended) An apparatus as in claim 18 [[23]], wherein said checksum includes 4-bytes of checksum data.

25. (Currently Amended) An apparatus as in claim 18 [[23]], wherein said checksum is included in a block-appended checksum.

26. (Previously Presented) An apparatus as in claim 25, wherein said block-appended checksum includes a further checksum for checking integrity of said block-appended checksum.

27. (Previously Presented) An apparatus as in claim 26 wherein said further checksum includes 4-bytes of data.

28. (Original) An apparatus as in claim 18 wherein said mass storage device includes a cache or RAM.

29. (Previously Presented) An apparatus as in claim 18 wherein said disk drives are formatted with 520-bytes per sector.

30. (Previously Presented) An apparatus as in claim 18, wherein said plurality of said sectors included in each of said storage blocks is eight sectors.

31. (Original) An apparatus as in claim 18, wherein said second subset includes 64-bytes of error code data.

32. (Original) An apparatus as in claim 18, wherein said first subset includes 4,096-bytes of data.

33. (Original) An apparatus as in claim 18, wherein said sectors include 520-bytes of data storage.

34. (Original) An apparatus as in claim 18, wherein said first and second subsets together include 4,160-bytes of data and error code storage space.

35. (Currently Amended) A method for protecting data from data storage errors, said method including

determining a plurality of storage blocks in a disk drive of a mass storage system having one or more disk drives, each of said storage blocks including a plurality of sectors, said storage system using parity data for error detection;

for each storage block of said plurality of storage blocks, dividing said storage block into a first subset and a second subset, and generating error code information responsive to data for a plurality of said sectors in said storage block;

wherein for each said storage block, said first subset is responsive to said data, and said second subset is responsive to said error code information; and

~~wherein said second subset includes integrity data for checking integrity of said second subset;~~

wherein said error code information includes a checksum of said first subset.

36. (Previously Presented) A method as in claim 35, wherein said disk drives are hard disks.

37. (Previously Presented) A method as in claim 35, wherein said disk drives are part of a RAID storage system.

38. (Original) A method as in claim 37, wherein said RAID storage system is a RAID level 4 system.

39. (Original) A method as in claim 35, wherein said second subset is appended to said first subset.

40. (Cancelled)

41. (Currently Amended) A method as in claim 35 ~~[[40]]~~, wherein said checksum includes 4-bytes of checksum data.

42. (Currently Amended) A method as in claim 35 ~~[[40]]~~, wherein said checksum is included in a block-appended checksum.

43. (Previously Presented) A method as in claim 42, wherein said block-appended checksum includes a further checksum for checking integrity of said block-appended checksum.

44. (Previously Presented) A method as in claim 43, wherein said further checksum includes 4-bytes of data.

45. (Original) A method as in claim 35, wherein said mass storage system includes a cache or RAM.

46. (Previously Presented) A method as in claim 35, wherein said disk drives are formatted with 520-bytes per sector.

47. (Previously Presented) A method as in claim 35, wherein said plurality of said sectors included in each of said storage blocks is eight sectors.

48. (Original) A method as in claim 35, wherein said second subset includes 64-bytes of error code data.

49. (Original) A method as in claim 35, wherein said first subset includes 4,096-bytes of data.

50. (Original) A method as in claim 35, wherein said sectors include 520-bytes of data storage.

51. (Original) A method as in claim 35, wherein said first and second subsets together include 4,160-bytes of data and error code storage space.

Claims 52 to 71 (Cancelled)

72. (New) An apparatus comprising:

an array of disk drives, each of said disk drives having a plurality of storage blocks for data;

parity data for stripes across said array, said parity data stored in said array; and

checksum data for said storage blocks, said checksum data stored in said array, said checksum data for each storage block being appended to that storage block in said array;

wherein said parity data and said checksum data in combination are capable of detecting at least bit errors in said data, sector slides in said data, and misdirected disk access operations.

73. (New) An apparatus as in claim 72, wherein said array is a RAID storage device.

74. (New) An apparatus as in claim 72, wherein each block includes a plurality of sectors of a disk drive, wherein said checksum data appended to each block resides in one of those sectors, and wherein said checksum data appended to each block is responsive to others of the sectors in that block.

75. (New) An apparatus as in claim 72, wherein said checksum data appended to each block further includes at least one block number for that block.

76. (New) An apparatus as in claim 75, wherein said at least one block number includes at least a virtual block number unique to said array and a disk block number unique to a disk drive on which said block is located.

77. (New) An apparatus as in claim 72, wherein said checksum data appended to each block further includes an embedded checksum for checking integrity of that checksum data.

78. (New) An apparatus as in claim 72, wherein said array includes a cache or RAM.

79. (New) A method of storing data comprising the steps of
storing said data in an array of disk drives, each of said disk drive having a plurality of storage blocks for data, the stored data including parity data for stripes across said array, said parity data stored in said array, and checksum data for said storage blocks, said checksum data stored in said array, said checksum data for each storage block being appended to that storage block in said array;

checking said parity data and said checksum data in combination to detect at least bit errors in said data, sector slides in said data, and misdirected disk access operations.

80. (New) A method as in claim 79, wherein said array is a RAID storage device.

81. (New) A method as in claim 79, wherein each block includes a plurality of sectors of a disk drive, wherein said checksum data appended to each block resides in one of those sectors, and wherein said checksum data appended to each block is responsive to others of the sectors in that block.

82. (New) A method as in claim 79, wherein said checksum data appended to each block further includes at least one block number for that block.

83. (New) A method as in claim 82, wherein said at least one block number includes at least a virtual block number unique to said array and a disk block number unique to a disk drive on which said block is located.

84. (New) A method as in claim 79, wherein said checksum data appended to each block further includes an embedded checksum for checking integrity of that checksum data.

85. (New) A method as in claim 79, wherein said array includes a cache or RAM.